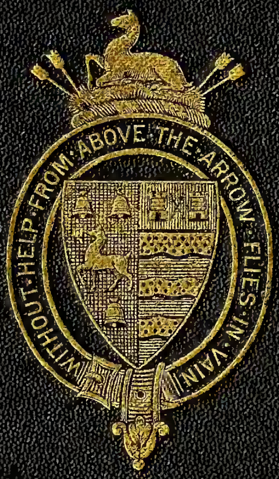
ON ASTHMA:

ITS NATURE & TREATMENT.



BY

DR. HORACE DOBELL.

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ON

ASTHMA:

ITS NATURE AND TREATMENT.

CONTAINING AN ENTIRELY NEW AND COMPREHENSIVE WORKING HYPOTHESIS,

SUGGESTIVE OF NEW REMEDIES AND OF THE MORE EFFICIENT APPLICATION OF OLD ONES.

ILLUSTRATED.

BY

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ETC., ETC.,

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PREFACE.

My first object in publishing this treatise is to excite discussion and further discovery in relation to a subject of the greatest practical interest in the daily lives both of Doctors and Patients.

Now that I have left London, I am out of the way of the usual arenas for medical and scientific discussion afforded by the various learned Societies; I shall, therefore, be greatly obliged to any of my readers who will take the trouble to send me their critical suggestions, whether favourable or unfavourable, in order that I may give their views careful consideration, while pursuing future investigations.

Streate-Place, Bournemouth,
February, 1886.

ON

THE NATURE AND TREATMENT OF ASTHMA.

NOTE.—The reader should open out the Diagram at the end of this Treatise for reference while reading.

IN 1862, when Dr. C. J. B. Aldis read his paper at the Royal Medical and Chirurgical Society "On the Poisonous Effects of Coal Gas upon the Animal System," I put the abstract of it aside, with a note to "consider the analogy of some of the phenomena with those of asthma."

Having often reconsidered this idea, it was reinforced by reading Dr. Gilbart Smith's Case of Poisoning by Coal Gas, which he so carefully reported in the *British and Foreign Med. Chir. Review* (January, 1877), and in which he recapitulated many of the facts referred to by Dr. Aldis.

In 1878, imbued with what Professor Whewell used to call "an appropriate set of ideas," and while engaged in investigating the behaviour of hæmoglobin and oxyhæmoglobin in relation to loss of weight and tuberculosis,* I was struck by Dr. Tidy's statement that other gases, such as *carbonic oxide,* are capable of combining with hæmoglobin, forming carbonic oxide hæmoglobin, which is of like red colour to oxyhæmoglobin, but *unlike it* in that when once formed the hæmoglobin cannot part with the carbonic oxide in the same way that it can with the oxygen. Hence the cause of death in poisoning by this gas.†

In November, 1878, in notes for future work, I entered the following—Query: "Is asthma due to some interference with, what Dr. Tidy calls, the ease with which the hæmoglobin combines with and also delivers up oxygen ? Probably it is an arrest in the delivering up of oxygen, which first disturbs the respiratory act."

Since getting out of the "hurly-burly" of London practice, in 1882,‡ I have found more leisure for thinking over some of my "notes for future work"; and a continuous run of bad cases of asthma, sent to Bournemouth for relief, having come under my notice, I have been specially reconsidering the whole subject of asthma, in its scientific and clinical aspects. The result has been a conviction that my query of 1878, may be made the basis of a more comprehensive working hypothesis than any other with which

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* See *On Loss of Weight, Bloodspitting and Lung Disease*, 1880.

† Dr. Tidy says:—"More recent experiments, however, have shown that breathing is not merely a physical, but a chemical act. In the red corpuscles a compound exists called 'hæmoglobin.' This body has a purple colour in venous blood, but is capable of combining chemically with oxygen to form a vermilion-red body called 'oxyhæmoglobin,' the colouring matter of arterial blood. The active agent in respiration is this hæmoglobin, a body remarkable for the ease with which it both combines with, and also delivers up oxygen. Asphyxia means the non-oxygenation of the purple hæmoglobin. Other gases, such as carbonic oxide, are also capable of combining with it, forming *carbonic oxide hæmoglobin*, which is of like red colour to oxyhæmoglobin, but, unlike it, in that, when once formed, the hæmoglobin cannot part with the carbonic oxide in the same way that it can with oxygen. Hence the cause of death in poisoning by this gas."—(*Handbook of Modern Chemistry, &c.* By CHARLES MEYMOTT TIDY, M.B., F.C.S. First Ed., 1878.)

‡ See *The Medical Aspects of Bournemouth and its Surroundings*, p. 1. 1885.

I am acquainted; and as the best way to test its validity is to put it into writing and submit it to professional criticism, I now attempt to do so in the plainest and briefest way I can.

Telegrams and telephones are now so familiar to all, and the general working of telegraphy bears so great an analogy to that of the cerebro-spinal system, that, for the sake of clearness in demonstration, I have put my SCHEME OF AN ASTHMATIC PAROXYSM into a sort of telegraphic diagram; in which messages and responses to them are indicated by arrows flying in different directions. The afferent messages being coloured red, and the efferent responses green. (See Diagram at end.)

The small figure at the foot of the Diagram represents the Organic Respiratory Reflex, by which automatic respiration is set up, in response to an afferent signal to the respiratory centre conveying information of the need of respiration, the "*Besoin de Respirer*" of French authors.

In the large diagram this Organic Respiratory Reflex is made the central figure, to which I have added—

1. A. B. C. The sources from which the afferent signals proceed.
2. The respiratory inhibitory centre in correspondence with the respiratory centre.
3. The cardiac, or circulatory centre.
4. The cardiac, or circulatory inhibitory centre in correspondence with the cardiac centre.
5. The vaso-motor centre.
6. The vaso-motor inhibitory centre in correspondence with the vaso-motor centre.
7. The will centre in correspondence with all other centres.

The messages to and from the several points are written along the shafts of the arrows indicating their source and direction.

It will be seen that my hypothesis is projected beyond and behind all other hypotheses. Starting from the hæmatin and hæmoglobin in the tissues and blood, and their relationship to respiration and histogenesis, I venture to believe that it will be found to bring those other hypotheses which have a rational *locus standi*, but which have hitherto been considered antagonistic, into possible and probable harmonious correlation.

Unfortunately the projectors and champions of each new hypothesis have been too apt to make the disbelief in every other hypothesis a *sine-quâ-non* in the acceptance of their own, instead of seeking a common standing-ground for all those based upon the investigations of reliable observers.

In my opinion, the following hypotheses and clinical observations cannot be ignored; and the hypothesis which I have projected brings them all into harmonious correlation:—

1.—THE NEUROSIS HYPOTHESIS.

"Asthma may, therefore, be considered as a neurosis of the pulmonary branches of the plexus of that name, similar to other neuroses."—(C. THEODORE WILLIAMS, *Quain's Dict.*, 1st Ed.)

In the same work, neuroses are defined to be "Affections of the nervous system occurring without any material agent producing them, ... in fact, functional affections of the nervous system."—(P. W. LATHAM.)

"For my own part, I am inclined to regard asthma as one of the rarer and major manifestations of the neurotic temperament."—(ROBERT SAUNDBY, "Notes on Asthma," *Birmingham Medical Review*, September, 1884.)

Future investigations and discoveries will show whether the fascination of the wonderful recent additions to our knowledge of the cerebro-spinal system and its functions, is leading us too often to cloak our ignorance as to causation in the mystic word "neurosis," somewhat as our forefathers used to do in such terms as "Idiosyncracy." But it is quite clear that, whether such functional disturbances "without any material cause" are possible or not, the occurrence of disturbances in the centres or conducting media involved in my diagrammatic scheme might produce some or all of the phenomena of an asthmatic paroxysm.

2.—THE BLOOD-GORGED HYPOTHESIS.

Dr. Patrick Black showed that "when the right heart acts too quickly or too forcibly, the lungs so swell the chest-cavity that little further expansion of this becomes possible by means of the most violent effort at inspiration. *The lungs are blood-gorged,* the air-vesicles remaining *empty of air* in proportion as they are *over-full of blood.* . . . . . No effort of the inspiratory muscles can draw in more air until the pump-action of the heart moderates. You see [says Black] what a difference it makes whether the chest is expanded by the muscular forces external to the lungs, or by the force of the circulation within them."—(*St. Bartholomew's Hospital Reports,* 1879.)

Although I never heard Dr. Black propose this as a complete hypothetical explanation of asthma, there is no doubt that his conclusions were the result of much observation and thought, and the forces to which he refers are well deserving of consideration as factors in some phases of an asthmatic paroxysm, as will be seen in my diagram, and may act as excitors of those attacks which are brought on by over-exertion and excitement accompanied by undue cardiac action, and must aggravate dyspnœa when the heart is urged, by the cardiac centres, to increase the blood-pressure in opposition to the attempts of the vaso-motor centre to close the arterioles—the epoch of highest arterial tension in the asthmatic paroxysm.

3.—THE CATARRHAL, OR MEMBRANE HYPOTHESIS.

Under this head may be included the attempts to explain the asthmatic paroxysm by changes excited, by various external and internal causes, in the membranous walls of the pulmonary pneumatic apparatus.

That highly vascular structures (*e.g.,* the nasal mucous membrane) are susceptible of a sort of erectile swelling, which, as in the case of the true erectile organs, may greatly affect their physical conditions, and that such erectile swelling may culminate and subside with extraordinary quickness, and without apparently altering the structures themselves, or leading to any secretion or effusion; are familiar facts of great importance, of which nettlerash is perhaps the most easily recognised illustration.

That membranes and tissues when irritated are liable to various degrees of tumidity and congestion, which may subside without effusion or increased secretion, but that such tumidity and congestion much more usually lead to effusion or hypersecretion; are also familiar and important facts.

That the more frequent the repetition of such states the greater is their liability to recur, and that many of them result in alterations of the normal condition of membranes, either temporary or permanent, and that such abnormalities are of a kind which *interferes with the osmotic functions* of membranes; are also indubitable results of observation.

It is upon these and similarly well authenticated results of clinical and scientific observation, that the Catarrhal or Membrane Hypothesis of the nature of asthma is based; and they have been provided for in my hypothesis.

I fully discussed these matters in 1866, 1872, 1874, in my work on "Winter Cough, Catarrh, Bronchitis, Emphysema, and Asthma;" and they are so well known to the profession, that I need not go further into them here than to mention that I have accorded to them an important place.

These phenomena could hardly be described in my Diagram without occupying too much space. But it is evident that they might occur as natural consequences of the events included in the Diagram.*

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* After these pages had been sent to press I had the pleasure of reading Sir Andrew Clark's Article on "Hay-fever and Bronchial Asthma" in the January number of *The International Journal of the Medical Sciences,* in which, what I have called, "The Catarrhal and Membrane Hypothesis," is so lucidly and comprehensively set forth that it is important to give

4.—The Perivascular Hypothesis.

This was projected by myself, in 1874, to co-ordinate certain observed clinical facts relating to what I have named "Sneezing Asthma." It is not inconsistent with the more comprehensive hypothesis now brought forward.

The persons subject to sneezing asthma are not always asthmatic, in the ordinary sense, but they seldom escape. Sometimes a patient will remain a sneezer, and escape asthma for years, and sometimes he may almost cease to be a sneezer, and become an asthmatic for years; sometimes he may begin as an asthmatic, and then change into a sneezer. Sometimes—and this is most frequently the case—he is both "a sneezer" and "an asthmatic"; one day the symptoms culminating in sneezing, and

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a summary of Sir Andrew Clark's views in his own words. He says: "They resemble, in some particulars, those published by Weber in 1872. They are, nevertheless, the views which I have taught at the London Hospital for the last twenty years.

"In the following series of propositions, I shall endeavour to set forth as concisely as possible, what I regard as the teaching of a study of hay fever, concerning the pathology of bronchial asthma:—

"1. Asthma is a neuro-vascular trophic disease, and has its roots in a special vulnerability of the respiratory mucous membrane, of the respiratory nerve centres, and of certain portions of the sympathetic.

"2. The irritation exciting the nerve discharges, which bring about the asthmatic paroxysm, may arise in the blood, in any of the mucous tracts, but more particularly the respiratory one, in certain cutaneous inflammations, and in the central nervous system itself.

"3. The paroxysm begins by a more or less diffused hyperæmic swelling of the bronchial mucous membrane, and is continued by the development, at various parts thereon, of circumscribed congestive swellings, which come and go with greater or less rapidity, and resemble, in many particulars, the swellings of the skin in nettlerash.

"4. At their first appearance these swellings become coated with a viscid mucus, hinder the entrance and exit of air, and by their vibration produce for the most part the drier râles characteristic of a certain stage of the asthmatic paroxysm. Toward the close of an attack, the swellings, after free secretion, subside, the dyspnœa is relieved, and moist take the place of dry râles.

"5. The secretion from the swellings being sometimes acrid, and even corrosive, may excite some contraction of the bronchial muscles; but such contraction cannot become, either by its nature or its amount, the chief factor in the evolution of the asthmatic paroxysm.

"6. The hyperæmia and circumscribed swelling of the bronchial mucous membrane hindering the free entrance of air, and thereby the full aëration of the blood, both the peripheral nerves and the respiratory centres are irritated, and exaggerated discharges of respiratory impulses are sent to the inspiratory muscles, which are thrown thereby into violent and sometimes even tetanic contractions.

"7. These violent inspiratory effects increasing the Hallerian extension force of the thoracic walls, straighten the bronchial tubes, and, notwithstanding the tendency of inspiratory forces to increase the size of the swellings, make the entrance of air into the lungs far easier than its exit.

"8. When the inspiratory efforts cease, and the expiratory recoil begins and is continued by the muscles of forced expiration, the smaller bronchi, more especially those containing mucous wheals, are compressed, and all the passages are relaxed and lose their straight direction. Thus the egress of air is greatly hindered, and the act of expiration so much prolonged that it is sometimes suddenly interrupted and prematurely closed by the violent inspiratory efforts originated in the respiratory nerve centres through the circulation of imperfectly oxidated and decarbonised blood. In this way inspiration gains upon expiration; the alveoli are extended with air; the diaphragm is depressed; the chest in all its dimensions is dilated; breathing becomes more and more difficult; death seems imminent; and the paroxysm is at its height.

"9. After a time, varying greatly in duration, the attack begins to subside, and, partly by secretion from the bronchial mucosa, partly from the exhaustion of the excitability of the respiratory and vasomotor centres, respiration becomes easy, lividity and swelling of the face disappear, restless anxiety is replaced by growing calm, and the attack is brought to an end." (p. 112.)

"It is alleged that the asthmas—the asthma connected with hay fever and the asthma which is not—are two very different affections. But the grounds for the allegation are untenable, and have been taken on the assumption that the action of pollen upon the nasal mucous membrane is the exclusive cause of hay fever. But I contend that other external agents are capable of producing this malady, and that sometimes it is provoked by disorders engendered within the system itself."—(p. 107.)

Dr. E. Cresswell Baber (*Brit. Med. Journal*, Feb. 6th, 1886,) says:—

"Dr. Bulkley's paper, in the *British Medical Journal* for November 21st, 1885, on Asthma as related to Diseases of another in asthma; or both sneezing and asthma may occur at once, in which case one or other generally takes the lead in severity, while the other passes off more lightly.

I have fully described the clinical aspects of these cases, and discussed their physiology *pro* and *con.* in the Introduction to the third edition of my work "On Winter Cough," under the head of "The Perivascular System and its relation to Diseases of the Respiratory Organs," pp. xxi. to xxxvi.; and I may refer any reader interested in the subject to that treatise, as it would occupy too much space to go further into it here than to quote the following paragraph:

"The hypothetical explanation which I have suggested is *an intermediate state common to all the given antecedents,* and in answer to the question, What is this intermediate state? I suggest that it is distension of the perivascular system of canals with liquor sanguinis, migrated from the red-blood vessels; that in the normal state an immediate return of fluid from the perivascular system to the red-

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the Skin, and the article by Sir Andrew Clark, on the Theory of Bronchial Asthma, in the current number of the *International Journal of Medical Sciences*, lead me to make a few remarks on the congestive theory of asthma. . . .

"The respiratory nasal mucous membrane contains, as is well known, a large tract of erectile tissue, which is chiefly situated on the inferior turbinated bones. This consists, roughly speaking, of numerous large venous vesels, which by their distension cause temporary swelling or erection of the turbinated bodies. The swelling may be observed going up and down very rapidly, and within certain limits is a normal occurrence. When excessive, and accompanied with sneezing and serous secretion, it constitutes the neurotic attacks which are very commonly seen quite independently of hay-fever. Sir Andrew Clark describes these cases as 'hay-fever'; but, inasmuch as they are unconnected with pollen, and are not accompanied by fever, the term is obviously inapplicable to them, and should be confined to those instances in which, from their occurrence at certain periods of the year, pollen is the probable exciting cause. The symptoms already mentioned may be attended by any of the numerous reflex phenomena now known to be associated with the nose, the chief of which are: cough, asthma, redness, and itching of the outside of the nose, nightmare, migraine, constant headache, supra-orbital neuralgia, giddiness, epilepsy, etc. Hay-fever is, therefore, according to this view, simply a neurosis of the nasal mucous membrane, accompanied by certain reflex phenomena, which at particular seasons of the year is produced by the pollen of plants in specially predisposed persons. In other cases, these neurotic attacks are caused by some local irritation in the nasal cavities (such as nasal polypi) or by other irritants inhaled in the air, or they are produced reflexly by the irritation of some other organ (for example, by the action of strong light on the eyes). The constitutional element is, as Sir A. Clark insists, a very important factor in the causation of these symptoms. When a morbid predisposition to erection of the turbinated bodies exists, very slight and trivial causes, which it is unnecessary to detail here, are sufficient to produce swelling of these structures.

"The intimate connection which exists between the bronchial mucous membrane and that of the nasal cavities is shown, not only by the occurrence of neurotic nasal symptoms (swelling of the turbinated bodies, watery secretion, and sneezing) at the commencement of an attack of bronchial asthma—a circumstance, in my experience, of very common occurrence—but also by the fact mentioned above, that asthma is frequently a reflex symptom produced by intranasal irritation, many cases of this description being now on record. If further proof were needed, Hack has reported a case in which an attack of bronchial asthma was produced by the application of a powerful irritant (galvanic cautery) to the nasal mucous membrane, in a person who had previously never suffered from the complaint. In many cases also, bronchial asthma has been temporarily or permanently relieved by treatment applied to the nasal cavities. These few points, which might easily be enlarged upon, suffice to indicate the intimate relation existing reflexly between the nasal and bronchial mucous membranes.

"It is, moreover, a remarkable fact that, in true hay-fever, all the other symptoms, with the possible exception of the sneezing, appear to be of a congestive (vaso-dilator) character, whence it may be argued that the asthmatic symptoms are probably of similar nature.

"Sir Andrew Clark not only compares the supposed bronchial swelling to that occurring in the nose, but speaks of 'mucous wheals' in the bronchi, and likens the swelling, which he supposes to occur there, to patches of urticaria, whose pathology, according to a recent authority (Fagge's *Principles and Practice of Medicine*, vol. ii., page 673) is that of 'acute inflammatory œdema of the cutis, which fills the lymph-spaces and expels the blood from the venules.' The much greater frequency of association of asthma with neurotic nasal symptoms than with urticaria, and the closer resemblance of the two mucous membranes, I venture to think, favour the view that if the dyspnœa of asthma, as seems probable, is produced by temporary tumefaction of the mucous membrane, such swelling partakes more of the nature of that occurring in the nose than of the wheals of urticaria.

"Whether the structure of the bronchial mucous membrane admits of its undergoing a pathological swelling, by simple distension of its blood-vessels, is a question which must be decided by future research."

blood vessels takes place on the return of normal circulation in them; and that the *abnormal physiological condition*, which exists in the peculiar cases under consideration, consists in a derangement of this power of instantaneous change of place between the contents of the two sets of vessels."

5. The Spasm of the Diaphragm Hypothesis.

"The muscles of inspiration, especially the diaphragm, are spasmodically contracted, and it appears to be now satisfactorily decided that this phenomenon is the true cause of the asthmatic paroxysm. We owe this discovery to Riegel of Cologne, the author of the article on Bronchial Asthma in Ziemssen's Cyclopædia. In a recent communication he has shown that the occurrence of the paroxysm depends entirely on the influence of the phrenic nerves, which supply the diaphragm. While he confirms the statements of C. J. B. Williams, Paul Bert, and others, who induced convulsive dyspnœa in dogs by stimulating the vagus, he shows that when both vagi are divided the paroxysms may be produced by stimulating their centrifugal ends, while if the phrenics are divided the occurrence of the paroxysm is entirely prevented."—(Robt. Saundby, M.D., *Op. cit.*, *Sept.* 1884.)

No one can doubt the correctness of the observations, clinical and physiological, which prove that the action of the diaphragm plays an important *rôle* in asthmatic spasm. It is inevitable that the great inspiratory muscle should do so in any respiratory act; and it will be found to occupy a prominent place in the Organic Respiratory Reflex (See Diagram), and consequently it also occupies an important place in the Diagrammatic Scheme of an Asthmatic Paroxysm. But diaphragmatic spasm is only one among many phenomena in the asthmatic paroxysm.

The experiments of Reigel and others appear to amount to this. The diaphragm is the great automatic respiratory muscle, the chief power in automatic *in*spiratory action. Spasm of this muscle must produce convulsive respiratory distress. The phrenic nerves are the efferent conductors of diaphragmatic action; therefore, of course, if the communication between the diaphragm and the respiratory centre is cut off by division of the phrenics, diaphragmatic inspiratory action cannot take place. Therefore, the convulsive diaphragmatic action (convulsive dyspnœa) in dogs, caused by irritating the vagi, and prevented by cutting the phrenics, is a true asthmatic paroxysm! I confess that I do not comprehend the logic of this conclusion. What it conveys to my mind is that Riegel, having decided *à priori* to call convulsion of the diaphragm an asthmatic paroxysm, proceeded to stop the action of the diaphragm, and then concluded that he had stopped an asthmatic paroxysm. To prove his own *à priori* conclusion, he was willing to admit that Paul Bert and others had produced a true asthmatic paroxysm by irritating the vagi, instead of disputing this conclusion first of all.

Let it be clearly borne in mind that diaphragmatic contraction favours *in*spiration, and inspiration only—a most important element in automatic respiration, as represented in the diagram of Organic Respiratory Reflex. No *complete* respiratory act can be uninfluenced by the part taken by the diaphragm. But much more is required than spasm of the diaphragm to constitute a complete asthmatic paroxysm.

6. The Bronchial Muscle contraction Hypothesis.

"The contractility of the muscular element in the small bronchial tubes under the influence of mechanical, chemical, and electrical stimulants was demonstrated by Dr. C. J. B. Williams in 1840. Afterwards Longet and Volckmann showed that irritation of the vagus nerve would produce contraction of the lung, or rather of the bronchial muscle. The last of these observers saw the lung contract, when the vagus was irritated, with force sufficient to blow out a candle.

"Paul Bert, Gerlach, and more recently Dr. H. MacGillivray, have confirmed these results, so that, as Riegel, one of the more recent writers on asthma, says, 'It is, therefore, now no longer doubtful that the bronchial muscles can be excited to tonic contraction under the influence of the vagus nerve.'

"The belief held by Floyer and Cullen—that the spasm of bronchial asthma was due to contraction of the smaller bronchial tubes—receives plenty of support in the present day. . . . Dr. Hyde Salter, has expressed himself strongly and decidedly as an upholder of the bronchial-constriction theory, and among other celebrated men of the same way of thinking I may name Trousseau, Romberg, Bergson, Biermer, Théry, Williams, Walshe, Fuller, Watson, Radclyffe Hall, Gerlach, MacGillivray, and others."—(J. C. THOROWGOOD, M.D. *Lettsomian Lectures*, 1885.)*

There can be no doubt that contraction of the bronchial muscle may be excited by irritation of the vagus, and that such contraction will produce respiratory distress, by first driving the air out of the finer air passages, that is, producing *ex*piration, and then interfering with its return with the *in*spiratory tide. But it is equally clear that there is no power in the lung to force this *in*spiratory tide without the aid of the diaphragm or other muscles of respiration, and that nothing approaching to an asthmatic paroxysm could be induced by contraction of the bronchi, that is by a single expiratory act, unless the *in*spiratory powers were brought into collision with it. Hence it was a foregone conclusion that cutting off the connection of the diaphragm with the respiratory centre, by severance of the phrenics, must stop any respiratory convulsion produced by the contraction of the bronchial muscle; and it was equally a foregone conclusion that no respiratory convulsion could be produced by contraction of the bronchial muscle without the aid of the muscles of inspiration.

But to assume that either the contraction of the bronchial muscle or the contraction of the diaphragm is the sole cause of a respiratory convulsion, because damage to one or the other can stop such a convulsion, would be like assuming that because by damaging any one of the wheels of a watch the watch will be stopped, therefore that particular wheel must be the mainspring of the watch.

It appears to me that the bronchial muscle occupies an analogous place with regard to the alveoli to that occupied by the arterial muscle with regard to the capillaries. They are both inhibitory; their contraction shuts off air or blood from the regions of physiological action, when the access of air or blood is offensive to the physiological areas.

If it is borne in mind that bronchial muscle contraction means expulsion of air, and contraction of the diaphragm means inspiration of air—the relationship between the bronchial muscle hypothesis and the diaphragm hypothesis will be appreciated.

Both occupy an important place in my Scheme of an Asthmatic Paroxysm; and I would commend to the opposing factions of these two hypotheses a careful consideration of the connections of the solar plexus.

Having thus briefly reviewed the several chief hypotheses as to the nature of an asthmatic paroxysm, I pass on to some of the more important and disputed clinical observations.

(A.) THE EXPIRATORY AND INSPIRATORY CLINICAL FACTIONS.

It will be seen from what has gone before that my hypothesis provides a *modus vivendi* for the two rival factions of clinical observers—one of which considers the *ex*piratory difficulty, and the other the *in*spiratory difficulty the main feature in an asthmatic paroxysm.

It seems strange that clinical observers of equal probity and experience should be ranged on opposite sides upon what, at first sight, appears to be such a necessarily self-evident phenomenon. Yet so it is!

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* "Bert has also demonstrated, as Williams had done before, that after excessive inflation of the lung the bronchial muscle could not be excited to contract; but Williams observed that on waiting a minute or two contraction took place, only diminished in degree by the compressed state of the air, which required more contractile force to move it."—(THOROWGOOD, *Op. cit.*)

"Asthma is recognised partly by the character of the dyspnœa, which in croup is *in*spiratory whereas in Asthma it is mainly *ex*piratory."—(C. THEODORE WILLIAMS, *Quain's Dict.*, 1st Ed.)

"*In*spiration is violent and painfully ineffectual. *Ex*piration is much prolonged, but unaccompanied with notable anguish."—(WALSHE, quoted by THOROWGOOD.)

"While *in*spiration shows nothing that varies from an ordinary powerful and somewhat forced effort, *ex*piration presents the picture of a most laborious and tormenting, and, at the same time, fruitless struggle."—(BAMBERGER and ZIEMSSEN, quoted by THOROWGOOD.)

"The chest remains distended, its walls are kept fixed in the extreme *in*spiratory position, such enlargement involving all the diameters of the thorax."—(HYDE SALTER.)

"*Ex*piration is mainly impeded, the patient labouring four or five seconds to empty his chest."—(BIERMER.)

"The lungs are usually collapsed within the thoracic cavity and the parietes drawn in."—(C. J. B. WILLIAMS, quoted by BERKART.)

"*In*spiration is difficult, *ex*piration short, easy, superficial."—(BERGSON, quoted by BERKART.)

Dr. THOROWGOOD thus sums the matter up:

"Lately a good deal has been said as to the *ex*piratory or *in*spiratory character of the dyspnœa during a fit of spasmodic bronchial asthma; and this is a question well worthy of study in its bearing on certain modifications of the asthmatic paroxysm. . . . . To me it appears that both respiratory acts are impeded more or less. Sometimes inspiratory difficulty is most urgent; at other times, and in other cases, expiratory effort is pronounced and unmistakable. My own reports of cases show me one group of patients who unhesitatingly refer their breath difficulty to the act of inspiration; others . . . . say that their sufferings during the paroxysms of asthma are so intense that they hardly can tell whether inspiration or expiration is most laborious. A third group, ... often spontaneously affirm that the desire they have is to get the air out of the chest rather than to get it in."—(THOROWGOOD, p. 15, *Op. cit.*)

I have watched these phenomena for many years and kept notes about them, and I believe from my experience that much of the confusion and apparent opposition has arisen from three principal causes.

1. Attempting to get at the truth by catechising asthmatics themselves. They are principally impressed with that which is attended with most evident *voluntary* effort, and with that which occupies the longest time and makes the most noise. I kept numerous notes at The Royal Chest Hospital of the answers of asthmatic patients on this matter, and at the end rejected them all as utterly worthless.

2. Making the notes of the expiratory and inspiratory sounds from what is audible when beside the patient, but without placing the ear to the chest. This is almost as deceptive as the preceding.

3. Not taking special note of the stage and intensity of the paroxysm, and whether or not it is complicated with catarrh at the time the respiratory sounds are recorded.

Every succeeding year's experience in this matter has confirmed the correctness of the statements which I made in my lectures on Winter Cough, at the Royal Hospital for Diseases of the Chest, in 1865, after a prolonged and elaborate clinical investigation of the matter in a very large number of cases.

These observations were made with the ear to the chest; and, as they completely express my present views on the subject, I quote them as printed in the third edition of my work, "On Winter Cough," 1875.

"All that we have to bear in mind, then, is that, *high pitch and rapid vibration and low pitch and slow vibration* are inseparable. . . . . . . "The inspiratory current is much faster than the expiratory, and, as the same volume of air has to be drawn through the tubes in a shorter space of time, the vibrations set up are more rapid, and the pitch is proportionately raised. That such is the case is subject to the simplest proof, for we have only to make a patient snatch a sudden forcible breath, and so increase still further the *rate* of the inspiratory tide, and the pitch will rise proportionately. On the other hand, if a gentle slow inspiration is taken, the pitch will sink; and then, by a short forced expiration, the expiratory sound may be made to *rise* in pitch till it is even higher than the previous inspiratory sound; or the same experiment can be tried with a common bellows; the pitch of the sound produced by the rush of air through the nozzle can be raised or lowered by increasing or diminishing its rate.

"If, then, in the natural state of things, the *in*spiratory sound is of higher pitch than the *ex*piratory, it is clear that any alteration in this relationship must proceed from some change in the physical conditions, and ought to excite our attention.

"It is evident that if the alteration of pitch in either of the sounds is due simply to an increase of rate in the current of air, other things being normal, the duration of the sound should *diminish* as the pitch increases—for a shorter time must be required to drive the same volume of air through the same tube at a rapid than at a slow rate. . . . . . .

"Well, then, the first and simplest cause of a rise in pitch in either of the respiratory sounds is an *increase in the* rate of current; and with this, if all else is normal, a *decrease in duration* must correspond.

"But, suppose the *pitch of one of the sounds is raised* and, at the same time, the *duration is not decreased*, then there must be a diminution in the calibre of the tube through which the current passes. For, given two equal volumes of air, driven at the same rate through two orifices, either they will pass in the same period of time, or the *sizes of the orifices* must be different. Therefore, *an expiratory sound which is both long and high pitched* must be due to a narrowing of the orifice through which it has to pass.

"But at this point a difficulty occurs which for a long time puzzled me very much to explain.

"The difficulty is this—How can it happen that a change in the calibre of a respiratory tube, through which both the inspiratory and expiratory currents have to pass, should affect one of these currents more than the other? For instance—if a bronchial tube is narrowed, why does it not raise the pitch of the inspiratory and expiratory sounds *in the same proportion,* and thus maintain the normal relation between their pitch? The explanation is that which I gave when speaking of backward pressure upon the air cells, viz., that the *moving powers* in the two cases do not remain the same. In normal respiration, the expiration is performed by the elastic recoil of the lung tissue, followed up by the elastic recoil of the chest wall; but directly there is an impediment placed in the way of the expiratory current, the expiratory *muscular* system is called into play, and thus a new element is added to expiration, which is not added to *in*spiration. An additional force of a new kind drives on the current in one case, and not in the other. But with this new element of force comes that other most important one, to which I have also referred, viz., that, whereas all *inspiratory* efforts tend to expand the chest, and, by taking off the superincumbent pressure to dilate the air tubes, all *expiratory* efforts tend to compress the lungs, and consequently favour the contraction of the tubes, and this becomes especially the direction in which *muscular expiration acts;* the air cells which lie upon and in the neighbourhood of the air tubes, are pressed upon them. The operation of forced expiration, therefore, acts in the direction to favour and increase the narrowing of the expiratory current, and to raise the pitch of its sound out of proportion to that of the inspiratory sound.

"There is a very interesting exception to this rule, which serves to prove it. In spasmodic asthma the *inspiratory* sound is raised in pitch more than the expiratory.

"This is due to the spasmodic contraction of the muscular fibres of the bronchi, excited by the attempts to inspire fresh air. They, in fact, offer a direct opposition to the normal inspiratory act, and almost paralyse it. They narrow the passage of the inspiratory current, and its sound is raised in pitch in proportion to the rate at which the inspiratory efforts succeed in drawing it through the narrowed passages. But these spasmodic contractions do not, as a rule, offer the same obstruction to the outward tide; the tubes, having been forced to yield to the inspiration * allow the air now warm and charged with carbonic acid, to escape with less opposition, renewing the vigour of their contraction at every new attempt to draw fresh air through them.

"We have, then, two valuable diagnostic physical signs plainly demonstrated:—

"(1.) A high-pitched long *ex*piratory sound must mean contraction of the respiratory tubes, independent of spasm.

"(2.) An abnormally high-pitched *in*spiratory sound, not accompanied by a corresponding change in the expiratory sound, must mean spasmodic contraction of the air passages.

"I will mention another clinical fact, which, while it presents a third diagnostic physical sign, confirms the correctness of the other two. If a contraction takes place in a respiratory tube, which is *rigid* in its character, and so situated that it cannot be favoured by either inspiration or expiration, the pitch of the inspiratory and expiratory sounds is alike affected by it. This may be best observed in affections of the larger air passages, such as rigid contractions of the openings of the larynx, compression of the trachea and bronchi by tumours, and the like. . . . . . .

"In the case of spasmodic contractions, it occasionally happens that the spasm is so capricious that it suddenly gives way during inspiration, and closes upon the expiratory tide; but this reverse of the general rule is but an exceptional case, and is not likely to recur in several consecutive respirations." (pp 55, 61.)

(B.) CONTRACTION OF THE MUSCULAR ELEMENT OF THE ARTERIOLES AND OTHER PHENOMENA OF ASPHYXIA.

It will be seen by the Diagram that, in the later stages of the paroxysm, the arterioles of the pulmonary circulation and of the systemic circulation are summoned to close against the blood current, by a command of the vaso-motor centre; in the same way as, in the earlier stages, the muscular element of the bronchi is summoned to close against the air current, by command of the respiratory centre. (See Diagram.)

"Perhaps the best illustrations of the obstruction to the passage of blood through the capillaries, *due to change in the blood*, is furnished by the phenomena of asphyxia or apnœa. As soon as the blood, charged with carbonic acid, reaches the systemic capillaries its passage through them is resisted, and the pressure in the arterial system rises enormously." ("*On the Causes and Consequences of undue Arterial Tension.*" By W. H. BROADBENT, M.D., *British Medical Journal*, August 25th, 1883.)

"Inasmuch as the cessation of respiration [in Asphyxia] means both oxygen-starvation and the accumulation of carbonic acid, the question is—whether the phenomena of asphyxia depend on the one or the other, or both. Various opinions have been entertained on the subject, but the experiments of Rosenthal and Pflüger would seem to show that the deprivation of oxygen is the chief factor. That the accumulation of carbonic acid has no effect at all, cannot, however, be maintained, for it is demonstrable that carbonic acid has a distinct toxic effect on living tissues. The respiratory centres ultimately become paralysed, but subsequently to those of conscious activity—the brain—and to those of reflex action—the spinal cord.

"The circulation of non-oxygenated blood, likewise causes contraction of the *arterioles* from irritation of the *vaso-motor* centre. Increased resistance is thus offered to the heart, and this is intensified by the convulsive muscular efforts. The arterial tension rises. The resistance to the flow through the capillaries by contraction of the minute blood-vessels *occurs not only in the systemic, but also in the pulmonic circulation.* Hence there is resistance both to the arterial and venous side of the heart. The ventricles become distended and the heart's action laboured. The heart becomes enfeebled by the circulation of non-oxygenated blood in its walls, the diastolic intervals become longer, until the heart finally stops in a state of diastole, with the right side full, while the left *may* have succeeded in emptying itself."—(Dr. FERRIER, *Quain's Dict.*, 1st Ed.)

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* Bert and Williams found that after excessive inflation of the lung, the bronchial muscle could not be excited to contract; but Williams showed that, after waiting a little, contraction took place.

"When an animal is placed in an atmosphere devoid of oxygen, or not containing a sufficient quantity of this gas (under 10 per cent.) to maintain the respiratory process, or if the mechanism of respiration is simply obstructed, it begins to show signs of agitation and to make powerful inspiratory and expiratory efforts, in which the accessory muscles of respiration are brought into action; the arterial tension increases."—(FERRIER, *Op. cit.*)

"We are able to distinguish three stages in the phenomena which result from deficiency of air.

"1. A stage of dyspnœa, characterised by an increase of respiratory movements both of inspiration and expiration.

"2. A convulsive stage, characterised by the dominance of the expiratory efforts and culminating in general convulsions.

"3. A stage of exhaustion in which lingering and long-drawn inspirations gradually die out.

"During the first and second stages of Asphyxia, blood pressure rises rapidly, attaining a height far above the normal (as seen by a manometer in the carotid artery). During the third stage it falls even more rapidly, repassing the normal and becoming *nil* as death ensues."—(MICHAEL FOSTER, "A Text-book of Physiology.")

It must be borne in mind that, although an asthmatic paroxysm presents many of the phenomena of asphyxia, they are never complete, and they are not present in the *initial stage;* and the question of the essential nature of the paroxysm must be considered in reference to the conditions antecedent to the initial stage—the cause before the effect.

But in the succession of the phenomena due to want of air, contraction of the arterioles, both pulmonic and systemic, is developed; and I have, therefore, found it a place in my Scheme of an Asthmatic Paroxysm. (See Diagram.)

[NOTE.—In the article already quoted, Dr. Broadbent pointed out that "The conditions under which arterial tension arises," are most of them "such as are attended with the accumulation in the blood of imperfectly oxygenated nitrogenous waste." That is, a class of conditions peculiarly characteristic of the gouty, the rheumatic, the eczematous, and the asthmatic diatheses; so that vaso-motor disturbance may be present from this cause, *when the paroxysm begins,* independent of asphyxia, and may thus form a serious complication.]

(C.) VOLUNTARY RESPIRATION. (See Diagram.)

We now come to the last stage of the asthmatic paroxysm before it yields; *i.e.*, to the means adopted by the organism for the prevention of complete asphyxia. The tired and half-poisoned automatic centres hand over the task of saving life to the higher powers, and the Will Centre keeps up voluntary or artificial respiration.

"Resuscitation from pure asphyxia is possible so long as the heart continues to beat.

"The chief indication in the treatment of asphyxia is to effect oxygenation of the blood by the introduction of air into the lungs.

"Chief reliance is to be placed on the methods of *artificial respiration*, which, after all, are the most simple and the most effectual."—(Dr. FERRIER, *Quain's Dict.*, 1st Ed.)

This stage of the asthmatic paroxysm may be long or short—according to the facility with which the initial cause gives way, and the normal behaviour of the hæmatin and hæmoglobin is restored. It is always very distressing and often very long; and it is, therefore, the one most easily watched, and most familiar to ordinary observers; who may be thus quite misled as to the phenomena of the earlier stages which they less often see. (See p. 12.)

Having now rapidly passed in review the principal hypotheses and clinical observations * which I have thought of too much importance not to be accounted for and comprised in any satisfactory working hypothesis of wide scope—and before discussing the primary idea of my scheme, I must refer again to the central figure of my diagram. The best explanation of this will be found in Professor Grainger Stewart's lucid "*Introduction to the Study of Diseases of the Nervous System,*" (1884); in which it is shown that Organic Reflexes involve the following conditions. (See Diagram):—

1. Sensory structures connected with the organs.

2. A centre capable of receiving and transmitting to motor structures, or transforming into motor power, the sensory changes.

3. Motor structures distributed to muscles.

4. A co-ordinating structure, whereby certain muscles shall be made to relax at the time that others are brought into contraction. When the appropriate stimulus is applied, changes are set up in the reflex centre which result, under normal conditions, in the performance of the act.

5. This reflex chain is, however, under the influence of higher inhibitory centres.

6. Within certain limits the *will* may keep the sphincters in action, or may bring the expelling muscles into play.

7. In diseases this mechanism may fail in any part of its course.

With regard to the Organic Respiratory Reflex, Professor Grainger Stewart says:—"It seems definitely ascertained that the respiratory process, although influenced in various ways by peripheral impressions from the lungs, from the skin, and other sources, is *mainly determined by influences exerted directly on the centre itself.* The circulation of venous blood within it induces the movement, and the more venous the blood, the greater is the activity of the respiratory centre. Moreover, it is the *want of oxygen,* not the excess of carbonic acid, that constitutes the respiratory stimulus. But, although the respiration is mainly set in action by the centre, peripheral influences do affect it in various ways. It is frequently modified by changes both in *afferent* and *efferent* nerve structures. There may be excessive irritation of the vagi, which results in increased *rapidity* of respiration. There may be irritation of cutaneous nerves of the chest, and consequent acceleration; there may be irritation of the superior laryngeal nerve, and consequent inhibition of the respiratory movement. There may, *on the other hand, be interference with* the motor nerves. The diaphragm may fail to play, or may play excessively, from changes in the phrenic, as may also the scaleni, supplied by branches from the brachial plexus; the intercostal muscles, supplied by the intercostal nerves; the abdominal muscles, supplied by the lower intercostal and first lumbar nerves. Besides these *ordinary* muscles of respiration, we may find abnormal action of the *extraordinary muscles* under circumstances of laboured breathing, the serrati supplied from the brachial plexus and the posterior divisions of the spinal nerves; the sterno-mastoid and trapezius, supplied by the spinal accessory and by deep branches of the cervical plexus; the levator anguli scapulæ, and rhomboidei, supplied by branches from the upper part of the brachial plexus. Besides these thoracic and abdominal movements, there are respiratory movements in the face and larynx, the nostrils being expanded, and the glottis opened up for the admission of air."

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* I regret that I have not been able, without overloading these preliminary observations, to describe many subsidiary hypotheses of much interest, chief among which, for clinical accuracy, is that of Dr. Berkart, referring to diseased foci in the lungs; although I cannot admit that these are more than incidental phenomena in the life-history of asthma.

With reference to POISONING BY COAL GAS mentioned in the commencement of this paper—an examination of the cases and experiments related by Dr. C. J. B. Aldis (*Medical Times and Gazette*, February, 1862), and by Dr. Gilbart Smith (*British and Foreign Medico-Chirurgical Review*, January, 1877), indicates, as suggested by Dr. Marcet in the discussion on Dr. Aldis' paper, that there are several poisons at work in causing death by coal gas.* Dr. Marcet said he believed that light carburetted hydrogen and olefiant gas (the hydro-carbon constituents of coal gas) act very differently from the carbonic oxide. Carbonic oxide produces death by altering the properties of the blood, whereas the light carburetted hydrogen and olefiant gas give rise in all probability to symptoms of anæsthesia. Insensibility occurs rapidly, the Will Centre is paralysed, so that the victim makes no attempt to escape from his poisoned atmosphere. Yet, as in Dr. Gilbart Smith's case, the patient who was found unconscious in the early morning and remained so at eleven o'clock, began to recover at half-past twelve, and after this "his recovery from the serious and at one time almost hopeless state was perfect, and was followed by no organic mischief or ill consequences whatever."

But then he was removed from the poisoned atmosphere, when first discovered, and placed under favourable conditions for restoration from the carbonic oxide poisoning, from which he would have died while in a state of anæsthesia had he been left alone; the essential points in restorative treatment for carbonic oxide poisoning being "exposure to fresh air, warmth to the surface, and *artificial respiration* when necessary."

In the asthmatic paroxysm sedative poisoning is a late symptom, instead of being an early one, as in poisoning by coal gas; and, as will be seen in the Diagram, the patient is saved by the intervention of the Will Centre, which sets up *voluntary artificial respiration*, and forcibly maintains life till the hæmoglobin resumes its normal function. Thus, the Will Centre plays the part which the doctor is called upon to take in a case of coal gas poisoning; in which, as we have seen, the sedative poison, by laying the patient low at once, makes him the passive victim of the slower acting poison.

I do not for a moment assert that the formation of carbonic oxide hæmoglobin is *the exact form of defect* in the hæmoglobin which sets up the asthmatic paroxysm. But it is a form of defect familiar to physicians, chemists, and physiologists; and it may, therefore, well be brought forward for the sake of analogy. Hæmatin and hæmoglobin are susceptible of so many *occult changes and attitudes* that further investigation and experiment are necessary before deciding what are the *exact forms of defect* which occur in asthma.

Dr. MacMunn, of Wolverhampton, who has so highly distinguished himself by his elaborate investigations, has already thrown much light upon the peculiar properties of hæmatin and hæmoglobin, and will, I have no doubt, soon succeed in discovering the rest.

With regard to the "*combining with and delivery up of oxygen by hæmoglobin*," referred to in my "Notes for future Work," made in 1878, and quoted in the commencement of this paper, as the basis of my hypothesis as to the nature of the asthmatic paroxysm:—Dr. MacMunn has quite recently (1885) made some remarkable discoveries while examining the respiratory processes in Sea Anemones. These have led him to the conclusion that it is important to distinguish between the "External Respiration" conducted in the blood current and the "Internal Respiration" conducted in tissues and organs (*e.g.* muscles), and, consequently, to distinguish the circulating blood hæmoglobin from the pigments, or modifications of the same pigment, belonging intrinsically to tissues and organs—which, as a class, he calls Histohæmatins, and when found in muscles Myohæmatin.

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* "Coal-gas is a compound gas, consisting of illuminants, diluents, and impurities. The *illuminants* are, olefiant gas (C_2H_4), and analogous hydrocarbons (C_3H_6, C_4H_8, etc.), and hydrocarbon vapors, such as the vapor of benzol. The *diluents* are, hydrogen, marsh-gas, and carbonic oxide. The *impurities* are, carbonic anhydride, sulphuretted hydrogen, and other sulphur compounds." (Dr. TIDY, *Op. cit.*) "There is little doubt that carbonic oxide is the most actively poisonous of the gases present." (TIDY AND WOODMAN'S *Handy-book of Forensic Medicine.*)

These histohæmatins, which are widely distributed throughout the animal kingdom, he considers are concerned in abstracting oxygen from the circulating blood, and probably fixing it in the tissues for the purposes of metabolism.

These discoveries fall in so completely with my hypothesis, that I have found it convenient to adopt Dr. MacMunn's distinctive term histohæmatin when referring to the changes taking place in tissues and organs—using the terms hæmoglobin and oxyhæmoglobin when referring to the changes occurring in the blood current.

As it is my primary object in this paper to place my hypothesis in as plain and practical a manner as possible before my professional brethren for their consideration, I am desirous of avoiding, so far as I can, the fascinating subtleties surrounding the investigation of hæmatin and hæmoglobin and their combinations and metabolism, lest I should mystify those who have not yet worked at the occult subjects of the chemistry and spectroscopy of the blood and tissues.

But the following extracts from Dr. MacMunn's "Observations on some of the colouring Matters of Bile and Urine, with especial reference to their origin, &c." (*Journal of Physiology*, Vol. VI., Nos. 1 and 2), have such a definitely practical relationship to my subject that they cannot be omitted.

COLOURING MATTERS OF URINE.

"The mistake which most people are guilty of is that of supposing that urine, either normal or pathological, owes its colour to one colouring matter. There are in pathological urines—excluding the influence of bile and blood—a great number of pigments and chromogens, of which some are *derivatives of bile and of hæmatin,* others oxidised derivatives of indol, skatol and other bodies of the aromatic series whose radicals are produced by the action of trypsin and other ferments on the proteids in the intestine. . . . There are two distinct kinds of urobilin (1) An incompletely metabolised body which is that known as 'febrile urobilin,' and which is found in a great number of pathological urines. . . . This kind of urobilin is almost the same as stercobilin. . . . I often regret that this pigment has been named *febrile* urobilin, as it occurs in many cases where there is no elevation of temperature, for example, in cases of functional derangement of the liver, dyspepsia, chronic bronchitis, valvular diseases of the heart, and other conditions. It seems to me that anything which alters the blood pressure in the liver may cause pathological urobilin to appear in the urine in large quantity; and, under normal conditions, all that part of it which escapes conversion into a chromogen is further oxidised in the blood into normal urobilin, and appears as such in the urine. . . . I believe there can no longer be a doubt that we may produce from hæmatin, by oxidation, a pigment very like, if not identical with, normal urobilin. This pigment is not the same as stercobilin and I believe it occurs in blood serum. . . . . But there is another pigment present occasionally in urine, which cannot be prepared from bilirubin or biliverdin, and this is a pigment of great interest from a *pathological standpoint.* It is that which I have named urohæmatin, but which might with greater propriety have been called urohæmatoporphyrin, since it bears a very striking resemblance to hæmatoporphyrin. . . . It is now five years since I found this colouring matter in the urine of a case of rheumatic fever, and showed that I could produce it artificially from hæmatin. . . .

" This pigment possesses a peculiar interest, as I find it in the urine of rheumatic fever with great constancy. . . . . In very slight cases I find it present in mere traces, and in cases which were, apparently, going to end in rheumatic fever, but in which the pain ceased after a few doses of salicylate of soda, I could, as a rule, find only pathological urobilin. . . . . . .

" Latterly I have also found urohæmatin in the urine of Addison's disease, which appears to me to be of importance, as it supports the view as to the function of the adrenals, which I published in abstract last December. If the function of the adrenals is to remove effete blood-pigment from the body or to convert it into something which can easily be removed, disease of them may prevent this taking place, and the effete pigment or its imperfect metabolite, may appear in the urine as urohæmatin. Hence, then, urohæmatin may appear in the urine under two totally different conditions: firstly, from over-production of *effete blood-colouring* matter or *effete histohæmatin,* in greater quantity than the blood-metamorphosing glands can deal with; or, secondly, in normal quantity but too much for *diseased* blood-metamorphosing glands to deal with, as in Addison's disease. . . . . . .

" The occurrence of Addison's disease without disease of the adrenals is no argument against my theory, because disease of any other organ in which metabolism of effete pigment takes place might bring about the same result, nor is the occurrence of diseased adrenals without bronzing of the skin an argument against it, because the other pigment-metabolising glands (among which is the liver) may take on increased activity, and be able to deal with the excess of effete pigment. . . . .

" We must acknowledge that, under certain diseased conditions, a pigment is found in the urine which has its origin not from bile pigments, but from hæmatin.

" Putting all the facts obtained together, it would appear that the stercobilin resulting from the putrefactive processes in the intestine, and accompanied by imperfectly changed biliary pigments, is taken up by the branches of the portal vein and carried into the liver, where it is probably again changed by the action of a ferment into a chromogen: a portion of this chromogen gets into the blood and is excreted in the urine as a chromogen. A portion may escape in the condition of biliary urobilin as such and appear in the urine in a further oxidised condition, or owing to disturbance of circulation in the liver a large portion of unchanged biliary urobilin may appear in the urine. Besides this, the urine, under normal conditions, may contain a pigment which has no biliary origin, and may be derived entirely from hæmatin; while in certain diseased states a reduction product of hæmatin, having no connection with bilirubin or biliverdin, and closely related to hæmatoporphyrin, may appear in the urine, and to a great extent, if not altogether, may replace urobilin. It is only by the careful use of the spectroscope that these colouring matters can be distinguished from each other."

The great interest of these observations and discoveries of Dr. MacMunn, in relation to my hypothesis, is that they show (1) How numerous are the influences which may cause alterations in the condition of the hæmoglobin of the blood and of the histohæmatins of the organs and tissues; (2) that some of the chief factors in such changes are the pigment-metabolising-glands, among which are the liver and adrenals; (3) that they occur especially in functional derangements of the liver, dyspepsia, chronic bronchitis, valvular diseases of the heart, and other conditions, and in rheumatic blood-poisoning; (4) that they are especially related to subtle processes connected with oxygenation; (5) that the kidneys have much to do with either eliminating these pigments or leaving them to infect the blood and tissues.

Alterations of colouration and pigmentation are among the most notable effects of climatic influences.* Commencing with such conspicuous differences as the black of the Nubian, the brown of the

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* See the Author's Experiments (Proc. of the Royal Society, Feb. 17th, 1859), " On the Influence of White Light, of the different Coloured Rays, and of Darkness on the Development, Growth, and Nutrition of Animals and Plants," in which the Experiments of Prof. Edward Forbes on the Depths of Primeval Seas are referred to.

Esquimaux, the pink of the Englishman, the snowy fur of Arctic animals, the gaudy plumage of Tropical birds, we come down by a thousand degrees and shades—among which may be mentioned the prevailing hues of plants and flowers throughout geographical areas—to the cadaverous tints of skin characteristic of the dwellers in malarious districts, and of the subjects of Marine Cachexia,* or even to the different complexions of the occupants of the garret and of the cellar in the same tenement.

These varieties of pigmentation are so intimately connected with the metabolism of hæmatin and hæmoglobin that they cannot fail to impress the mind with the occult effects which Climate may exert upon the functional perfection of the hæmoglobin in the pulmonary blood, and hence upon the etiology of asthma.

No one who has had much clinical experience of asthma can have failed to notice (*a*) the peculiarities of abnormal pigmentation characteristic of the chronic sufferer; (*b*) the suppression of the colouring matters of the urine during an asthmatic paroxysm; (*c*) their excretion, in abnormal proportions, as it clears off; (*d*) the constantly recurring relationship between asthma and occult blood changes, such as occur in suppressed skin eruptions, malarious poisoning, gout, rheumatism, perverted menstruation, numerous varieties of dyspepsia, and in hepatic derangements; (*e*) the mysterious effects of climatic and meteorological influences, especially such as disturb the electrical and oxygenating conditions of the atmosphere; (*f*) the no less mysterious and peculiar nature and action of the *curious variety of remedies* which different asthmatics find most potent in cutting short a paroxysm of asthma.

All these clinical facts, and many others that might be enumerated, can now be rationally accounted for by disturbances in the behaviour of the histohæmatin and hæmoglobin in what Dr. MacMunn calls the "Internal respiration, conducted in the tissues and organs," and the "External respiration conducted in the blood current."

In my Diagrammatic Scheme of an Asthmatic Paroxysm it will be seen—that I have made the first signal of distress to the respiratory centre start from the (A) "tissues requiring the hæmoglobin of the systemic capillaries to deliver up oxygen to the histohæmatins;" the message being to the effect that the hæmoglobin is failing to deliver up oxygen to the histohæmatins. And that I have made the second signal of distress to the respiratory centre start from (B), the "sensory structures in the lungs connected with the vascular and pneumatic apparatus by which oxygen from the respired air is absorbed by the hæmoglobin of the blood;" the message being to the effect that the hæmoglobin is failing to absorb oxygen.

It is evident that, in different cases, this order might easily be reversed, or that both signals might be sent at the same instant. And so with the other signals in the diagram—the order of their transmission would depend, in different cases, upon the point at which the organism first became sensible of a distressing disturbance of function; and this might depend upon the relative hypersensitiveness or defective sensitiveness of the structures. And no doubt this neurotic or hyperneurotic element has misled some speculators into the error of considering the primary defect to be in the nervous system. Again it is quite certain that there are conditions and circumstances under which the *Organic Reflexes* appear to postpone their duty, until the intervention of the Will Centre is necessary to call up the automatic process. A familiar example of this is seen when the bladder is allowed to become over-distended during sleep, and, on the person being wakened, micturition cannot be set up without a painful voluntary effort, or perhaps, if the delay has been too great, not at all until stimulated by the intervention of surgical aid.

It is well known that the worst attacks of asthma occur after a sound sleep; and I think this may easily be explained by supposing that several of the first signals of distress, given in my diagram, have been neglected by the respiratory centre, until a confusion has arisen in responding to them; or, in bad cases, by supposing that, the signals and responses having been duly carried on, the patient only wakes when the Will Centre is called upon, by the accumulated difficulties expressed in the combined signals 8, 9, 10 from A, B, C, to the respiratory centre, and by the despairing appeal from the respiratory centre, made in response to them, for voluntary help from the Will Centre in the shape of artificial respiration forced on by the action of the supplementary muscles. (See Diagram.)

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* See chapter iii., "On Marine Cachexia," in the Author's work "On the Medical Aspects of Bournemouth," etc., 1885.

In such a case, just as asphyxia is imminent, the Will Centre plays the part of the doctor, who in a case of coal-gas poisoning saves his patient's life by setting up artificial respiration, as I have already suggested at page 17.

It is necessary to remember this in the treatment of asthma, and to be careful not to administer any narcotic that shall stultify the Will without having first removed the essential causes of the paroxysm.

Some important clinical manœuvres may be based upon the preceding considerations.

If a patient is suffering from attacks of asthma coming on after each continuous sleep; the severity of the paroxysms may be diminished by having the sleep broken at the first sign of high-pitched *in*spiration—that is at the commencement of bronchial contraction—and some remedy being employed to cut short the attack at this stage, instead of waiting for a further accumulation of difficulties; or advantage may be taken of the fact (stated at pp. 11 and 14) that when the bronchioles are over-distended muscular contraction is postponed, and measures may be contrived to slightly impede the *ex*piratory tide during sleep—and thus to keep up slight bronchial distension—and everything should be avoided that favours the collapse of the thoracic walls—such as heavy bed-clothes above the waist, the arms folded on the chest, and the like.

In chronic sufferers from asthma the respiratory centre appears to learn by practice to *bear for a longer time* a defective supply of oxygen without setting up dyspnœa, than the less-practised centre will endure; and, in this way, slight and temporary arrests in the normal absorption and delivering up of oxygen by the hæmoglobin are allowed to right themselves without producing a paroxysm. The respiratory centre becomes educated to know exactly the point at which need for action begins, and remains calm and passively watchful of events, instead of becoming panic-stricken at the arrival of the first danger-signal from the tissues or lungs; somewhat in the same way as an experienced railway traveller stands stolidly on the platform after the "five-minutes bell" has startled the novices into a rush for seats, and then, at the last moment, slips safely into his carriage.

This power of education in the respiratory centre is seen in divers, who are able to suspend respiration up to the last possible period consistent with life, without any signs of panic.

If all the conditions which have been passed in review in this paper are borne in mind while the Diagram is before us, it is easy to work out any problem, connected with varieties in the clinical features and etiology of an asthmatic paroxysm, by changing the *venue* of the action, as the lawyers would say—in one case laying the action in defect of one part and in another case in defect of another part, and so changing the order of the signals and responses.

It is necessary always to bear in mind in this, as in all other medical considerations, that *a beam is no stronger than its weakest part*, and, as Professor Grainger Stewart says (*op. cit.*, p. 108), after enumerating the conditions essential to a complete organic reflex (see p. 16):—"In disease the mechanism may be altered at any part of its course. The sensory structures may be at fault. Sensibility may be either abnormally acute or impaired. The afferent impression may fail to reach the spinal cord, and consequently no reflex action be performed. Or the impressions may be cut off above the reflex centre, and the patient may be unconscious of the state of the organ. In such cases, the inhibitory influence is lost. The reflex centre may be diseased. It may be irritated so that its functional activity is excessive, or it may be cut off from its inhibitory centre. It may have its power diminished or abrogated in consequence of disease, such as myelitis, involving its substance. Perhaps the motor influences may be interfered with in consequence of disease of efferent nerves. Certainly co-ordination may be affected, so that there is a failure of the harmonious action of different sets of muscles. The muscular structures themselves may be at fault, and thereby the function disturbed."

In addition to the foregoing caution, as to the possible defect of some part of the mechanism, it must always be borne in mind, in considering the phenomena of an asthmatic paroxysm as depicted in my Diagrammatic Scheme, that *it is very rare for any one element of the paroxysm to be complete or continuous.* For example—the defect in the functions of the hæmoglobin is rather an interference of varying degree than a complete and continuous stoppage; the contraction of the bronchial muscle is fitful, both in degree and in localisation; the spasm of the diaphragm is intermittent and occurs sometimes during contraction and sometimes during relaxation; increased cardiac pressure and vaso-motor spasm appear and disappear.

If it were not for this incompleteness and want of continuance in the several phenomena, the patient would much more often succumb to the paroxysm, and death from asthma would be a common, instead of a very rare occurence. The incompleteness of the effects of carbonic acid poisoning upon the nerve centres accounts for the apparent incongruity, in their behaviour under the asthmatic paroxysm and in *experimental* asphyxia. (See pp. 14, 15.)

In the orthodox order of events in experimental asphyxia the Will Centre is disabled by carbonic-acid poisoning *before* the automatic centres of organic reflex, and hence the chance of preserving life by voluntary respiration is lost, as in the case of coal-gas poisoning.

But in the incomplete, intermittent, fitful phenomena of an asthmatic paroxysm, the automatic centres are only sufficiently poisoned to cause them to *give up under the over-fatigue* of prolonged exertion, and in their alarm at the sense of impending paralysis, *they call upon the Will Centre for assistance;* and the Will Centre, not being exhausted and not yet being too poisoned to respond to the call, takes up the struggle for existence—and by maintaining artificial respiration, stops the further progress of carbonic-acid poisoning, either of itself or of the other centres, and thus the battle is won.

At page 20 I have referred to "the mysterious and peculiar nature and action of the curious variety of remedies which different asthmatics find most potent in cutting short a paroxysm of asthma," and I have suggested that these may now be rationally accounted for by the present hypothesis.

It is easy to conceive how one or the other remedy may relieve *different stages* of the paroxysm, and hence *different patients,* or the same patient at *different epochs,* according to the order in which the various elements of the paroxysm take precedence in their urgency, and thus give rise to the prominent symptoms which first excite the attention of the sufferer to the need for help. (See pp. 12 and 17.)

Suppose, for example, a case in which treatment is commenced on the first arrest in the normal functions of the hæmoglobin; such remedies as could restore the normal action between the air in the alveoli and the pulmonary blood would be successful; and these would necessarily be of the most subtle description (see pp. 19, 20), such as climate and meteorological changes, fumes, gases, vapours, and other means of influencing the condition of the air in the respiratory passages;* and this includes the largest class of empirical remedies depended upon by asthmatics.

Supposing, as another example, that treatment is commenced when contraction of the bronchial muscle is the prominent symptom (see p. 10), such remedies as stramonium, belladonna, conium, chloroform, and ether would be the most likely to relieve this pressing difficulty.

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* "The absorption of any gas by any liquid will depend upon the nature of the gas, the nature of the liquid, the pressure of the gas, and the temperature at which both stand."—MICHAEL FOSTER (*Op. cit.*).

Again, supposing the mucous membrane to have become blood-gorged or œdematous (see pp. 7—9), antimony, ipecacuanha, lobelia, counter-irritants, and other similar remedies would give the greatest relief, and might be a *necessary preliminary* to any resumption of the normal relations between the hæmoglobin and the air.

Or, again, after other remedies had restored the normal functions of the hæmoglobin, portions of the pulmonary mucous tract might remain so blood-gorged or œdematous as to require the action of antimony, ipecacuanha, counter irritation, etc., before the *effects* of the paroxysm could be cleared away.

Or in cases of the hyperneurotic class, in which a general panic of the nerve centres is set up on the first signal of distress (see p. 21), and the vaso-motor muscles in the systemic and pulmonary system are precipitately closed (see pp. 14, 15), alcohol, ether, nitroglycerine, nitrite of amyl, &c., would be the remedies calculated to give the most speedy relief.

It is also in the hyperneurotic class of cases that a variety of circumstances, capable of diverting the attention of the nerve centres from trivial signals of difficulty in the organism, have such striking effects in postponing or altogether passing by a paroxysm (see p. 21), and in which such sedatives as opium are capable of preventing panic, and by thus favouring normal co-ordination throughout the organism, assist in relieving the asthmatic paroxysm.

Or, again, when the prominent difficulty is the restoration of the normal action of the diaphragm and other respiratory muscles, electricity, strychnia, medical gymnastics and means for the removal of flatulent distension of the stomach become potent remedies.

But the great clinical fact to be drawn from my hypothesis is this:—that for permanent cure of the asthmatic tendency we must look to such constitutional treatment as may remove those defects of the blood which induce abnormal conditions of the hæmatin and hæmaglobin. (See pp. 19, 20.)

The intelligent management of every case of asthma must therefore include at least four heads of treatment.

1. Means for the relief of the paroxysm.
2. Means for removing the vestiges of the paroxysm.
3. Means for avoiding the causes of disturbance in the functions of the hæmoglobin.
4. Means for restoring a normal condition to—the blood making organs, the blood metamorphosing organs, the pigment forming and pigment metabolising organs and the eliminating organs.

Under Class 3—means for avoiding the causes which disturb the normal functions of the hæmoglobin in the pulmonary circulation—must be ranged, not only climatic and meteorological considerations and all special idiosyncrasies as to smells, &c., but the all-important question of Digestion.

Disturbances of digestion, which play such a prominent part in the asthmatic rôle, are principally of two classes. The first, I have referred to when speaking of the diaphragm, viz., the flatulent or other disturbances of the stomach after food, impeding the free action of the respiratory muscles. This is the one most easily dealt with in treatment; for emetics to empty the stomach of solid contents, or remedies for the expulsion of flatulence are at once simple and efficient remedies.

But by far the most potent and most frequent difficulty, in the relation between the stomach and the asthmatic paroxysms, occurs at the time when the new food from the digestive organs is being poured into the lungs. Any excess or any defect of this nutrient current may overtax, paralyze or otherwise disturb the oxygenating processes, and at once bring on the initial step in the asthmatic paroxysm—the failure of the hæmoglobin to absorb or to deliver up oxygen. (See Diagram.)

No asthmatic patient should sleep till the chance of this difficulty has passed by; and, therefore no asthmatic patient should fill the blood with new food late at night, that is for at least four to five hours before lying down to sleep. Hence, it is often a good plan to order such patients to sleep *before dinner* so as to enable them to keep up longer after dinner without *exhaustion*, which, it must be remembered, is in itself capable of predisposing to a paroxysm.

In a bad attack of asthma there is sometimes a stage, more or less marked, and more or less prolonged, which I am accustomed to call "the phantom paroxysm." Against this it is necessary to be on our guard in the clinical description of phenomena (see p. 12), lest we make a mistake, which I have often seen made in practice, between the paroxysm and its ghost; and in the selection of special means of treatment this discrimination is of the utmost importance.

In my diagrammatic scheme it will be seen that the last signal given (response from Respiratory Centre to signals 8, 9, 10) is a despairing appeal from the Respiratory Centre to the Will Centre to call into action the voluntary muscles, and keep up artificial respiration till the hæmoglobin has resumed its normal function of absorbing and delivering up oxygen, and, of course, until the blood has become sufficiently oxygenated to release the organism from the complex series of difficulties which accumulate up to that point, and then rapidly subside.

We must be on our guard—Not to be deceived into thinking that the *initial difficulties continue to exist* because the patient is still struggling to keep up voluntary artificial respiration—not to mistake the "phantom paroxysm" for the true physiological paroxysm. (See p. 12.) He may continue this struggle with all the *primâ facie* appearance of having still to fight against impending asphyxia, simply because the *tired* automatic centres of organic reflexes have neglected to appreciate that their difficulties are over, and to inform the Will Centre that once again the respiratory process may be left to them with safety. (See pp. 20, 21.)

I shall never forget a striking case, illustrating this point, which occurred to me a few years before I left London.

Just after sunrise one summer's morning (August, 1878), I received a distressed note from a well-known young physician, a neighbour of mine, in Harley Street, begging me to come and help him with a patient *in extremis* from a prolonged asthmatic paroxysm. He met me at the door of the house looking as worn and distressed as though he were himself the patient. He told me in a few words, as we went upstairs, that the patient, aged 60, was a confirmed asthmatic, well versed in managing an ordinary paroxysm for himself with remedies he had always at hand, and upon which he was accustomed to rely; but that, in the present instance, all these had utterly failed, as had also every other remedy the physician had thought it safe to try. The paroxysm had lasted with unmitigated force about 24 hours; the doctor had been with the patient since 9 p.m., and now it was about 5 a.m. As we entered the sick room the smell of all sorts of combustibles, and glimpses of galvanic apparatus, inhalers, physic bottles, &c., &c. told of the conflict which had been waging during the night. Near the window—through which the morning sun was coming in from across the Regent's Park—leaning forward, on a high-backed chair, his arms over the backs of two other chairs, sat a tall, gaunt, worn-out looking man, struggling with might and main for breath, as he cast at me a half-hopeless, half-imploring glance. It was evident he could not keep up such exertions much longer; and, at first sight, the aspect of the case was as bad as both patient and physician thought it.

I made a rapid survey of the essential phenomena of an asthmatic paroxysm:—The high-pitched inspiratory wheeze (see pp. 11-14), indicative of bronchial spasm, was not there! Diaphragmatic spasm (see p. 10) was not there! Arterial tension (see pp. 14, 15) was not there! The choked heart, the cyanotic nails and lips, indicative of carbonic acid poisoning, were clearing up! (See p. 14.) The expiratory tide was long and laboured, but moist with mucous râles. (See pp. 7—9.)

It was clear to me that the battle was already won (see p. 22), but the troops had not yet rallied from the confusion of the fight—that the patient was, in fact, now labouring under a "phantom paroxysm." The tired automatic centres were neglecting to resume their duties, while the Will Centre was still so impressed with the dread of asphyxia, that it would not give up the struggle to maintain artificial respiration, although the hæmoglobin was again absorbing and delivering up oxygen, and the need for voluntary aid was over.

Having convinced the doctor that this was the rational view of the situation, we put the patient back to bed, propped up high with pillows; threw open the window to let in the fresh summer air; gave him a very decided dose of brandy and meat juice to stir up his heart and rouse his Organic Respiratory Reflex friends to a sense of their duties; pushed on mucous secretion by a dose of iodide of potassium; eased the conscience of his Will Centre with gr. xx. of chloral hydrate; promised the patient he would soon be well (the best restorative in our armoury); and darkened the room for sleep.

In the afternoon I had the pleasure of getting a note from the physician, saying, "After you left I gave a little more brandy, and in a little while the patient became easier, and fell into a doze, which though disturbed, did him good, and when I left he was fairly easy. He has mended all day, and when I paid my farewell visit he was quite comfortable and cheerful."

No chloral, and very little alcohol had been given before my arrival, because in previous attacks they had always done more harm than good, and the patient was, therefore, strongly opposed to both. But, then, they had only been tried during the persistence of the real paroxysm, before the hæmoglobin had resumed its functions of absorbing and delivering up oxygen; and the result in this case shows the necessity for nicely suiting the remedy to the stage of the complaint.

I have seen many cases in the "phantom" stage. It is the one most conspicuously distressing to bystanders, and most bewildering and disappointing to the patient—who is alarmed by the thought that all the remedies he has been accustomed to rely upon have failed, and by feeling that his strength is nearly exhausted. Hence it is often the time at which the doctor is urgently appealed to for assistance.

I am convinced that much of the antagonism and confusion in the descriptions of the clinical phenomena of asthma have arisen from different observers taking notes of different phases of the paroxysms, and especially in their not appreciating the difference between the true paroxysm and its phantom. (See p. 12.)

In going carefully through the Diagrammatic Scheme in the manner I have suggested at pp. 20—22, we shall see how greatly the clinical phenomena must vary, as one or other of the elements of the paroxysm comes into prominence, or subsides. It is as deluding to describe the complete paroxysm from the characteristics of one of its stages, as it would be, in music, to judge of a symphony from a single phrase.

In employing those remedies which especially aim at acting through the inspired air upon the lining of the air passages, and upon the pulmonary blood (see p. 22), it is evident, that the nearer they can be brought to those portions of the respiratory tract in which the physiological changes take place, the more rapidly and potently they ought to act. For this reason no one can be surprised to find that by the use of a form of inhaler which I have designed, specially calculated to attain this end, better results are obtained from the usual remedies than by the ordinary methods of applying them.

The woodcut and directions, given at p. 32 will at once demonstrate the mode of action of this simple contrivance, which I have given to Messrs. Maw, Son and Thompson, as the best means of promoting its use, and I have advised them to call it "Maw's Special Inhaler for Asthma."

In the 3rd Edition of my work "On Winter Cough," &c. (pp. 194, 249), I gave a list of the remedies then (1875) in use for asthmatic spasm. And with the kind assistance of Mr. Martindale, the celebrated pharmaceutical chemist, of New Cavendish Street, London, I have now supplemented this list, making it fairly exhaustive up to the present time. In this long catalogue of remedies, many of which are nostrums, all those which are to be used as powders, papers, cigarettes, pastilles, or vapours will be more potent in their effects if the inhaler I have designed is employed; and much smaller quantities of the ingredients will suffice. When only a few drops of volatile remedies, such as iodide of ethyl, nitrite of amyl, chloroform, &c., are to be inhaled, the small funnel will answer best, but the large one must be used for all papers, powders, cigarettes, pastilles, &c., that have to be burned. The cigarettes must be broken up, like the powders, to make them burn.

An examination of the remedies here enumerated shows that they are chiefly made up of repetitions in different forms of the following ingredients:—1st, Nitrate of potass, as a basis; 2nd, Datura stramonium and Datura Tatula; 3rd, Lobelia; 4th, Cannabis indica; 5th, Belladonna; 6th, Coffee and caffeine; 7th, Arsenic; 8th, Iodide of potassium. The *exact* composition of many of the nostrums is not known, but it is pretty well ascertained by chemists that they consist of the above remedies more or less concealed by a variety of innocuous adjuncts.

The different Alkaline and Neutral Salts enter so largely into the composition of the mineral waters famed for the cure of asthma, that their mere enumeration in a list gives no fair estimate of the large extent to which they are employed; and Coffee—now represented by its alkaloid Caffeine—has so long been universally regarded as a safe and reliable domestic remedy, that it is extensively used.

Bromides, Iodides and Ethers are so frequently ordered by medical men in prescriptions; and Arsenic is so largely used in the waters of La Bourboule and Mont Dore, that their importance is much greater than appears at first sight.

LIST OF FUMING PAPERS, POWDERS, PASTILLES, CIGARETTES, &c., FOR ASTHMA, which can be used with the "Special Inhaler," the *dose being carefully adjusted by a medical man* in each case:—

Abyssinian Powder (containing a quantity of Stramonium). (French).
Andru's Asthma Paper (French).
Arsenical Cigarettes (Trousseau's.)
Barral's Paper and Cigarettes (French).
Belladonna leaves (to smoke).
Camphor.
Cigarettes of Boudin and of Dioscorides (Arsenic—French).
Coca Pastilles (2½ grs. Ext. Coca).
Compound Lobelia Powder (Lobelia, Stramonium, Tea, Nitre), analogous to Himrod and Green Mountain Cure.
Cresoline.
Davies' Asthma Paper.
Dr. Palmer's Papers (Dublin).
Datura Tatula, Cigarettes and for pipe, Pastilles, &c. (Savory and Moore).
Dowling's Medicated Paper (Reading).
Espic's Cigarettes (French).
Eucalyptus Globulus Leaves to smoke.
Green Mountain Cure (Bliss's), (Lobelia, Stramonium, Tea, Nitre).
Grimault's Cannabis Indica Cigarettes (French).
Himrod's Powder (Lobelia, Stramonium, Tea, Nitre).
Hockens' Remedy (Isle of Wight) (Stramonium and Nitre).
Huggins' Ozone Papers and Cigarettes (199, Strand).
Joy's Cigarettes.
Kidder's Pastilles (American).
Le Vasseur's Arsenic Cigarettes (French).
Marshall's Cubebs Cigarettes (American).
Martindale's Asthmatic Pastilles (nitrate and chlorate of potassium).
Papier Fruneau (à Nantes).

Pariss's Cigarettes Pulmoniques (Bell).
Nitre Paper.*
Powder for Fuming: Datura Tatula, Stramonium, Cannabis Indica, Lobelia Infl., of each ʒvj.; Pot. Nit. ℥j, Olei Eucalypti glob. ʒss., (Mr. Beverley, Scarborough).
Savar's Cigarettes (Cannabis Indica, Stramonium, Cubebs).
Senior's Asthma Remedy (American) (powder).
Slade's Cigarettes (Long Acre).
Stramonium Leaves (to smoke).
Stramonium Cigarettes.
Strickland's Opium and Compound Opium Cigarettes (Dr. Reginald Thompson).
Sulphuretted Hydrogen Spray (at Allevard-les-bains).
Tobacco (to smoke).
Whitcomb's Asthma Remedy.
VAPORS (great caution is necessary as to dose and frequency of repetition):—
  Chloroform.
  Ether.
  Iodide of ethyl.
  Nitrite of amyl.
  Sulphurous Acid Vapor.

LIST OF INTERNAL REMEDIES FOR ASTHMA.

Actæa.
Amber.
Ammoniacum.
Antimony.
Arsenic.
Assafœtida.
Aubrée's Potion Asthmatique.
Belladonna.
Bromide of Potassium.
Caffeine.
Camphor.
Cannabis Tannas.
Cannabis Indica.
Castor.
Chekan.
Chloral Hydras.
Chlorate of Potass.
Coca and Cocaine.
Colchicum and Colchicin.
Croton Chloral.
Daturine.
Delphinia.
Emetics.
Euphorbia Pilulifera (Australian Remedy).
Glykaline (Leith and Ross's Homœopathic) 1 per cent. solution of iodide of potassium in spirit and water flavoured).
Grindelia (Californian Remedy).
Hare's Asthma Cure (iodide of potassium is a leading ingredient).
Iodide of Potassium and Ammonium.
Ipecacuanha.
Jaborandi and Pilocarpine.
Lobelia Tinct. and Etherial Tinct.
Musk.
Nitrate of Potass.
Nitrite of Sodium.
Nitro-glycerine, 1 per cent. solution or tablets.

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* "It is a singular circumstance, affording a marked example of the '*caprice*' of asthma, that a paper, prepared with nitre only, will relieve one patient, yet will utterly fail to relieve another, although a nitre paper, prepared in a different manner, may be quite successful. It must be borne in mind, therefore, that although one kind of nitre paper has failed, it does not necessarily follow that another sort of nitre paper will also fail. Sometimes a thin paper fails where a thick one succeeds, and *vice versâ*. It appears, indeed, that very slight differences in the mode of manufacture influence the therapeutic effects."—(Ringer, 7th Ed., p. 214.)

It has always appeared to me that these differences, in the effects of different specimens of nitre paper on different patients, are due, chiefly, to the varying amount of woody fibre and other components in the paper, and the varying susceptibility of different patients to the fumes of such matters. Contrivances by which the nitre fumes can be obtained without the paper smoke are desirable improvements.

Nux Vomica.
Opium and its Preparations.
Paraldehyde.
Pulsatilla.
Quebracho.
Stramonium Extract and Tincture.
Sumbul.
Tar Water.
Urethrane.

EXTERNAL APPLICATIONS.

Artificial Respiration.
Baths and Douches.
Blisters and other Counterirritants.
Dry Cupping.
Electricity.
Gymnastics ("Ling's Movement Cure," now taught by Dr. Roth.)
Pneumatic Appliances (compressed air bath, &c.)

After studying the various forms and complications of asthma, its predisposing and exciting causes and the different remedies which alone or in combination deserve the greatest confidence in its treatment, we shall be prepared to understand the remarkable successes recorded at Mont Dore from the use of its arsenical saline waters, taken internally, and applied in a variety of ways, at different temperatures and in different forms, to the skin and mucous membranes. (See the author's works "On the Mont Dore Cure, and the Proper Way to Use it"; and "On the Medical Aspects of Bournemouth and its Surroundings," p. 168, 1885.)

When treating of the catarrhal or membrane hypothesis, I referred (p. 16) to a "subsidiary hypothesis" to which Dr. Berkart has paid special attention, which attributes the asthmatic paroxysm to the effects of localised foci of disease in the lung. I dealt with this aspect of the subject at length in my work "On Winter Cough"; I specially pointed out the influence which inflammatory complications have in preventing antispasmodic remedies from exerting their usual beneficial effects, and (p. 249) I recorded a typical illustrative case. I introduce the subject here for the purpose of pointing out the great benefit which is to be obtained in such cases from *counterirritants,* especially in the form of blisters. If the ordinary effects are not produced by antispasmodics, and a patch of partially-consolidated or of choked lung, or a diffused bronchitis is detected, the application of blisters, with, perhaps, the assistance of antimony (never to be given without ammonia) is often an effectual and necessary prelude to other remedies—which will then act with their accustomed potency. (See p. 23.)

In concluding this enumeration of the remedies for asthma viewed in the new light which I have attempted to introduce, I wish to ask for a conspicuous place in future investigations for A METAL AND ITS COMPOUNDS, which *up to the present time has been quite untried* in practical medicine.

There is a body which is so singularly analogous to hæmoglobin in its behaviour to oxygen that I think it deserves our most careful attention.

This is anhydrous oxide of barium (BaO.) This body has the property of *absorbing* oxygen from atmospheric air and *delivering it up* again under the influence of slight diminution of pressure,—as hæmoglobin absorbs oxygen from the air in the lungs and delivers it up to the tissues and organs in the processes of nutrition. (See p. 1.) The fact, that BaO requires a slightly relieved pressure to induce it to deliver up the absorbed oxygen, is no argument against the analogy; for we not only have no knowledge that such an influence is not brought to bear in the organism, but there is reason to believe that something analogous to a suction power is exerted upon the capillaries in the process of nutrition;

and we do know, in the case of carbonic acid in the blood, that when treated in the laboratory of the chemist instead of in that of the organism, "the vacuum produced by the ordinary air-pump is insufficient to extract all the gas from the blood"—the mercurial air-pump being required—whereas it is readily given off in the lungs.—MICHAEL FOSTER (*Op. cit*).

Boussingault ("Ann. de Chemie," III. xxxv. 5) proposed to use caustic baryta, as a means of preparing oxygen on a large scale, by alternately passing atmospheric air over the baryta, raised to a dull red heat, and then expelling the absorbed oxygen by intense ignition. But the process could not be worked with sufficient facility.

All difficulty has now been overcome by the recent discovery of the fact, to which I have referred, that BaO will absorb oxygen from the atmosphere and then deliver it up under the influence of diminished pressure; and I believe that the Messrs. Brin, Frères, of France, have patented a process on this basis for the purpose of procuring oxygen on an enormous scale for commercial purposes.

Up to the present time barium and its salts have not been used in medicine. They have been regarded as too poisonous or too inert. "The carbonate and all the soluble salts (of barium) act as powerful poisons. . . . the best antidote, when they have been taken internally, is the sulphate of soda or of magnesia." (*Elements of Chemistry.* By W. ALLEN MILLER, 2nd Edition.)

"All the barium compounds are soluble, colorless (if the acid be colorless), and poisonous . . . . Baric oxide, *Baryta* (BaO), is the residue left on igniting Baric Nitrate. It freely absorbes moisture and carbonic anhydride, and slakes with water, forming Baric Hydrate. . . . . Baric Hydrate, *Caustic Baryta* (BaH_2O_2), . . . rapidly absorbs CO_2. It is not decomposed by heat. It is soluble in water (1 in 20 at 60° Fah. and 1 in 3 at 212° Fah.), but is almost insoluble in alcohol.

"Baric Carbonate, *Witherite* ($BaCO_3$) . . . is *insoluble* in water containing saline matter, *almost insoluble* in pure water, but *soluble* in water containing CO_2.—(TIDY'S *Handbook of Modern Chemistry*, 1878.)

"Barium is but little known in a free state. Both it and its soluble salts are very poisonous. . . .

"The symptoms produced by baryta and its salts are those of an irritant poison. . . . Towards the close of the case, brain and nervous symptoms usually occur, such as giddiness, cramps, paralysis and violent convulsions. Death has resulted from one drachm of the chloride, whilst bad symptoms were produced in one case by less than three grains given in divided doses. . . . Death has occurred in one hour and been delayed for seventeen. . . .

"Orfila has pointed out that the salts of barium are quickly absorbed, and may be detected after death in the liver, spleen and kidneys."—(TIDY and WOODMAN'S *Handybook of Forensic Medicine and Toxicology*, 1877.)

However alarming these poisonous properties of Barium and its salts may, at first sight, appear to be, we shall find that they are not a whit more so than those of arsenic; and there is no more reason for assuming that barium cannot be brought into use as a medicine, in proper forms and doses, than there was that arsenic could not be so used before experience had proved the contrary. The symptoms of arsenical poisoning "are those of an *intense irritant* . . . . . . The nervous symptoms are intense and long continued." They may terminate in several ways—"(*a*) Convulsions, with fits of an epileptic nature. Tetanic spasms, and, in one case, lock-jaw, are recorded as early symptoms. (*b*) The case may merely assume the form of English cholera . . . . (*c*) Collapse . . . . (*d*) Intense coma . . . . (*e*) Death may be almost immediate, as if by shock. . . . . . . The *time of death* varies greatly. . . . . As regards *fatal quantity,* Orfila asserts that, however much arsenic may be taken into the stomach, the whole quantity absorbed in case of death never exceeds 1·5 to 2 grains. . . . . In a case recorded by Dr. Letheby, 2·5 grains proved fatal to a girl of 19.—(WOODMAN AND TIDY, *Op. cit.*)

The analogy which I have pointed out between the behaviour of BaO to oxygen and the behaviour of Hæmoglobin to oxygen appears to me to invest it with extraordinary interest, as a posssible medicine of the highest value in those occult changes in the blood, connected with defective action of the blood-metamorphosing organs, and the pigment-forming and pigment-metabolising organs and processes, referred to at pp. 18—20. And this interest especially applies to the treatment of the constitutional causes of asthma. (See pp. 22, 23).

In answer to inquiries addressed to Dr. MacMunn as to the possible presence in the blood of barium, or its compounds, he wrote to me, January 29th, 1886 :—" I believe nobody has found any salt of barium in hæmoglobin or hæmatin. Hæmoglobin contains only O. H. C. N. S. and Fe., and its formula is—$C_{600}\ H_{960}\ N_{154}\ Fe\ S_3\ O_{179}$. (Hoppe-Seyler, Preyer, Schmidt.) Hæmatin, according to Hoppe-Seyler, contains :—$C_{68}\ H_{70}\ N_8\ Fe_2,\ O_{10}$. So that the only metal present in either is Fe.

" Still there is no reason why the hæmoglobin molecule should not link on to itself a salt of barium. It is remarkable that an analogous substance, hæmocyanin, contains copper, so that a metallic constituent seems a help to the discharge of the functions of the proteid. I have *just found* that myohæmatin contains some iron, and that it is a crystallized proteid like hæmoglobin."

These inquiries are only in their infancy, and if Dr. MacMunn, after all his previous experiments, has only "*just found*" iron, further investigations may discover some other metal.

With regard to the future use of Barium and its salts as medicines, which I have here suggested ; of course, it will be necessary to follow the same cautious methods of procedure as have been adopted with arsenic, aconitine (" the most powerful poison known."—Woodman and Tidy), and other virulent poisons, now used every day in medical practice with perfect safety. Careful experiments must be conducted in physiological laboratories and hospitals, where the effects can be narrowly and constantly watched and noted, so as to leave no room for accidents. I commend the subject to such careful and experienced clinical, physiological, and pathological observers as Dr. S. Ringer, Dr. Murrell, Dr. Klein, Dr. MacMunn, Professor Greenfield, Dr. Saundby, Professor Rutherford, and others.

POSTSCRIPT ON THE TREATMENT OF HAY-FEVER.

In each variety of hay-fever some modification of treatment is required ; but in the majority of ordinary cases the following is the treatment which I have found most successful :—

First.—A person, subject to hay-fever at certain seasons or under certain conditions, should, throughout the whole year, keep a lump of camphor in a muslin bag in his pocket by day and under his pillow by night. Night and morning this should be placed first to one nostril and then to the other (the opposite nostril being closed), and the camphor inhaled strongly, steadily, and slowly, till it is felt in all the post-nasal passages and down the back of the throat. This should be repeated at any time during the day or night, if any catarrhal symptoms are felt.

Second.—A bottle containing one part of glycerine of borax and two of water or orange-flower water, should be always at hand, and the nostrils should be moistened with this whenever they feel dry outside or in.

Third.—On rising, each morning *throughout the year*, a large sponge, wrung out of cold water in summer, and water with the chill off in winter, should be pressed for one minute upon the forehead, brows, and root of the nose, and then for one minute on the nape of the neck.

By the steady perseverance in these measures the catarrhal tendency is remarkably diminished, and becomes less each year.

Fourth.—Directly the hay-fever season, or period, begins, or the symptoms threaten, the foregoing means should be *supplemented* as follows:—

A three-drachm stoppered bottle, filled with sponge, should be kept in the pocket by day and under the pillow by night, and the sponge should be saturated once or twice a day with one measured drachm of a saturated solution of camphor in equal parts of tincture of opium, spirits of wine, and chloroform, which should be kept in *a separate* stoppered bottle, labelled "Poison," and the prescription and directions plainly written upon it, to prevent accidents.

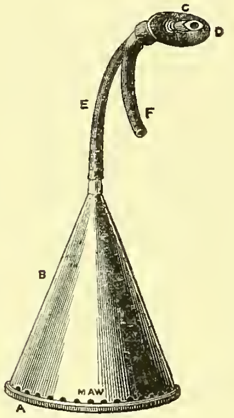
When there is the slightest threatening of a sneeze or other signs of hay-fever coming on, *the little bottle, with the saturated sponge in it,* should be unstoppered and applied first to one nostril and then to the other, and the vapour snuffed up till the threatening symptoms are allayed, and then it should be quickly re-stoppered.

No part of this treatment should be omitted, or used without the rest; and, if a cure is desired, it should be followed up, in season and out, throughout more than one year, so as gradually and permanently to overcome the hyper-neurotic condition of the mucous tract.

I may mention, also, that the vaporarium of "the Mont Dore Cure" is of immense comfort during an attack of hay-fever, and one or two courses of three weeks each of the Mont Dore treatment have a decided influence in overcoming the hay-fever tendency. This is now brought within the easy reach of all who can run down to Bournemouth.

MAW'S SPECIAL INHALER FOR ASTHMA.

(*Referred to p.* 25.)



A Large and a Small Funnel are supplied, adaptable to the same Mouthpiece.

DIRECTIONS FOR USE.

Put the *fuming paper or powder, or other inhalant,* on the plate (A) ; cover it with the funnel (B).

Take the *mouthpiece* (C) between the teeth, and press the *shield* (D) against the corners of the mouth.

Pinch the *long tube* (E) with the thumb and finger, and *expire* slowly, through F, to the last possible atom of breath.

Quickly let go of (E) and pinch the short tube (F) instead ; and then *inspire,* through E, steadily and deeply till the lungs are as full as they can hold. *Pause* with them *full* if you can.

Repeat the above process till asthma is relieved.

If more air is required while inspiring, let go of the short tube (F).

If less fume or other inhalant is required while inhaling, pinch the long tube (E).

NOTE.—The elastic tubes should be kept extended—not bent, both when in use and not in use.

By the above means the lungs are emptied of air in their deeper parts, and the inhalant is drawn into them, and is thus brought into more intimate physiological relation with the blood and nerves of respiration than by the usual modes of inhaling, and, as a consequence, the Asthmatic Paroxysm is more rapidly and certainly overcome.

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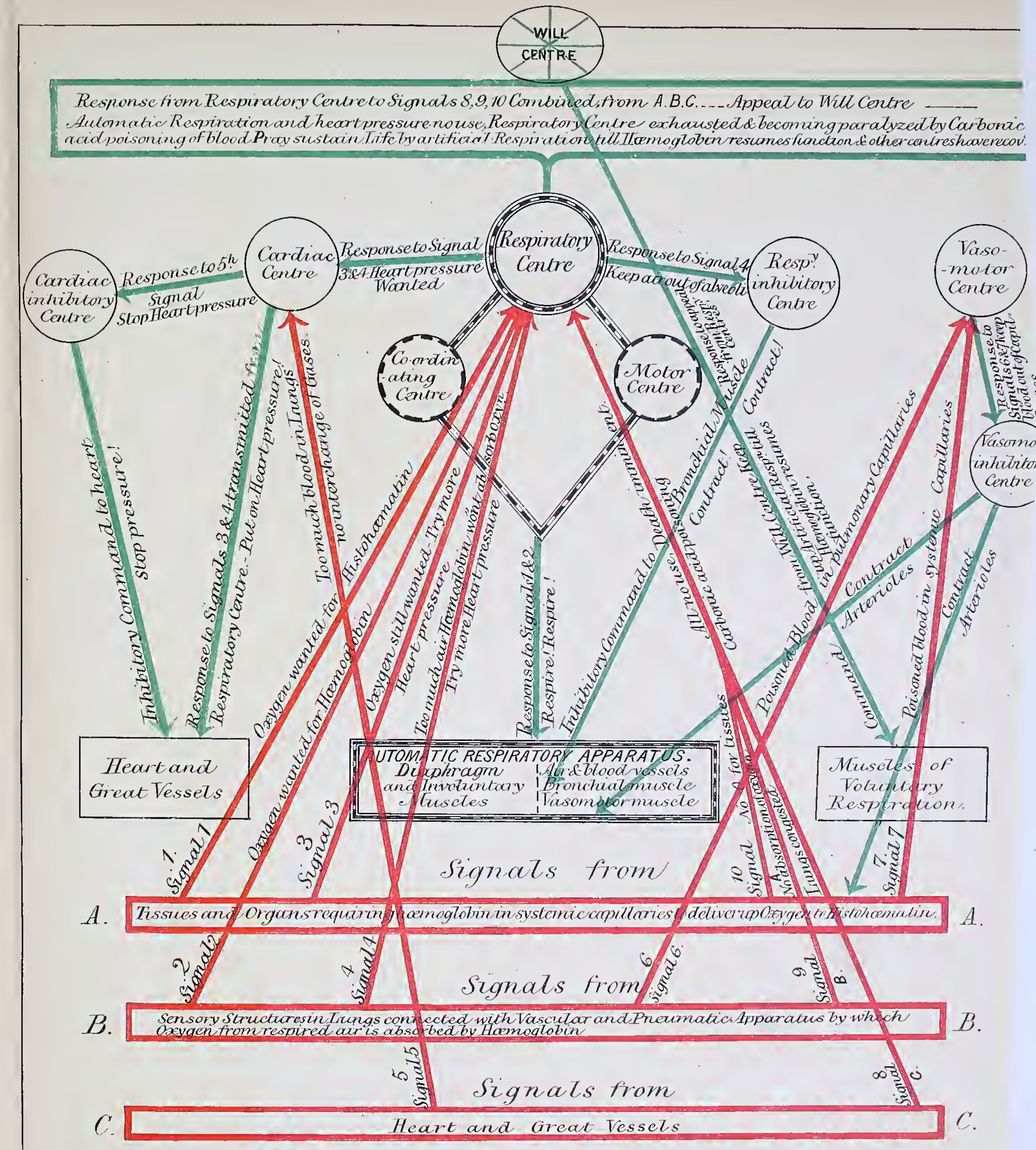
WILL CENTRE
Response from Respiratory Centre to Signals 8, 9, 10 Combined, from A. B. C. --- Appeal to Will Centre ———
Automatic Respiration and heart pressure no use, Respiratory Centre exhausted & becoming paralyzed by Carbonic acid poisoning of blood Pray sustain Life by artificial Respiration till Hæmoglobin resumes function & other centres have recov.
Cardiac inhibitory Centre
Response to 5th Signal Stop Heart pressure
Cardiac Centre
Response to Signal 3 & 4 Heart pressure Wanted
Respiratory Centre
Response to Signal 4 Keep air out of alveoli
Respy. inhibitory Centre
Vaso-motor Centre
Response to Signals 6 & 7 keep blood out of capillaries.
Vasomot. inhibitory Centre
Co-ordinating Centre
Motor Centre
Inhibitory Command to heart stop pressure!
Response to Signals 3 & 4 transmitted from Respiratory Centre. - Put on Heart pressure!
Too much blood in Lungs no interchange of Gases.
Oxygen wanted for Histohæmatin
Oxygen wanted for Hæmoglobin
Oxygen still wanted - Try more Heart pressure
Too much air Hæmoglobin won't absorb oxygen
Try more Heart pressure
Response to Signals 1 & 2 Respire! Respire!
Inhibitory Command to Death imminent.
All no use, Carbonic acid poisoning
Bronchial Muscle Contract!
Contract!
Response to appeal from Resp. Centres
Will Centre Keep Respn till
up Artificial Respn resumes Hæmoglobin function.
Poisoned Blood from
in pulmonary Capillaries
Command Contract Arterioles
Poisoned blood in systemic Capillaries
Contract Arterioles
Heart and Great Vessels
AUTOMATIC RESPIRATORY APPARATUS.
Diaphragm and Involuntary Muscles
Air & blood vessels
Bronchial muscle
Vasomotor muscle
Muscles of Voluntary Respiration.
1. Signal 1
Oxygen wanted for Hæmoglobin
3 Signal 3
Signals from
10 Signal No A for tissues
A. No absorption of oxygen
Lungs congested
7. Signal 7
A.
Tissues and Organs requiring hæmoglobin in systemic capillaries to deliver up Oxygen to Histohæmatin.
A.
Si. 2 Signal 2
4 Signal 4
Signals from
6 Signal 6.
9 Signal B.
B.
Sensory Structures in Lungs connected with Vascular and Pneumatic Apparatus by which Oxygen from respired air is absorbed by Hæmoglobin
B.
5 Signal 5
Signals from
8 Signal C.
C.
Heart and Great Vessels
C.

Diagramatic Scheme of an Asthmatic Paroxysm.

(To Illustrate Dr. Dobell's Treatise on the Nature & Treatment of Asthma)